Enabling the Physics Goals with Underground Facilities and Infrastructure

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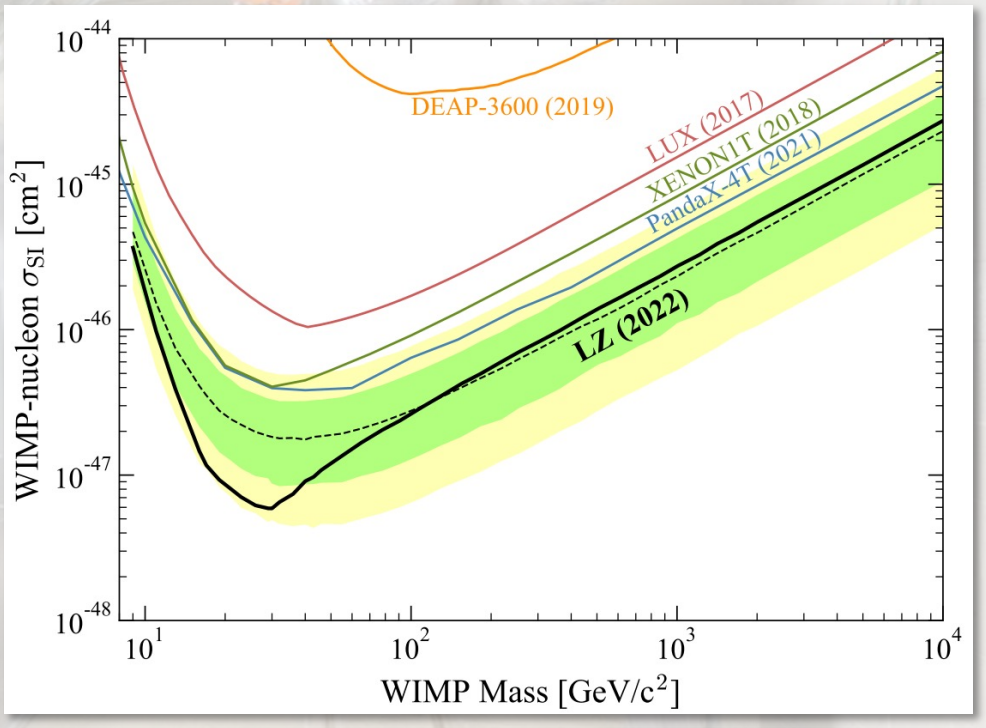
Underground Facilities & Infrastructure (UF): goals at the beginning of Snowmass

- Frontier Objectives & Goals
  - Determine science programs performing research in underground facilities
  - Collect information on existing underground facilities & infrastructure (supply)
  - Collect current/future needs for science in underground facilities (demand)
  - Compare demand to supply (gap analysis)
  - Analyze to generate a recommendation for an integrated strategy for underground facilities & infrastructure

Extraordinary progress has been made on realizing the underground research vision from Snowmass 2013

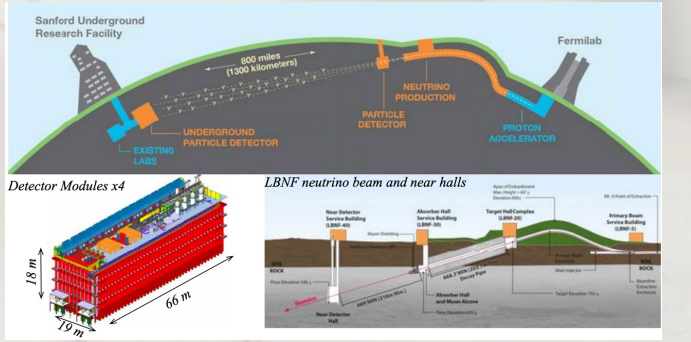
- G2 dark matter direct detection is nearing successful completion
  - Enabling next generation concepts
  - Infrastructure sufficient for DMNI concepts
- Underground neutrino physics has delivered and is poised for more discovery
- Supporting capabilities (e.g. material assay, safety, operations) successfully scaled up to the requirements of the science program



Recent results from the first LZ science run show the experiment is on track to deliver the G2 WIMP sensitivity. (arXiv:2207.03764)

The Long Baseline Neutrino Facility includes world-class underground infrastructure

- Excitement about the investment in this international-class underground facility
- LBNF enables US science priorities in accelerator-based neutrino experiments
- R&D for DUNE modules of opportunity may require unique underground infrastructure

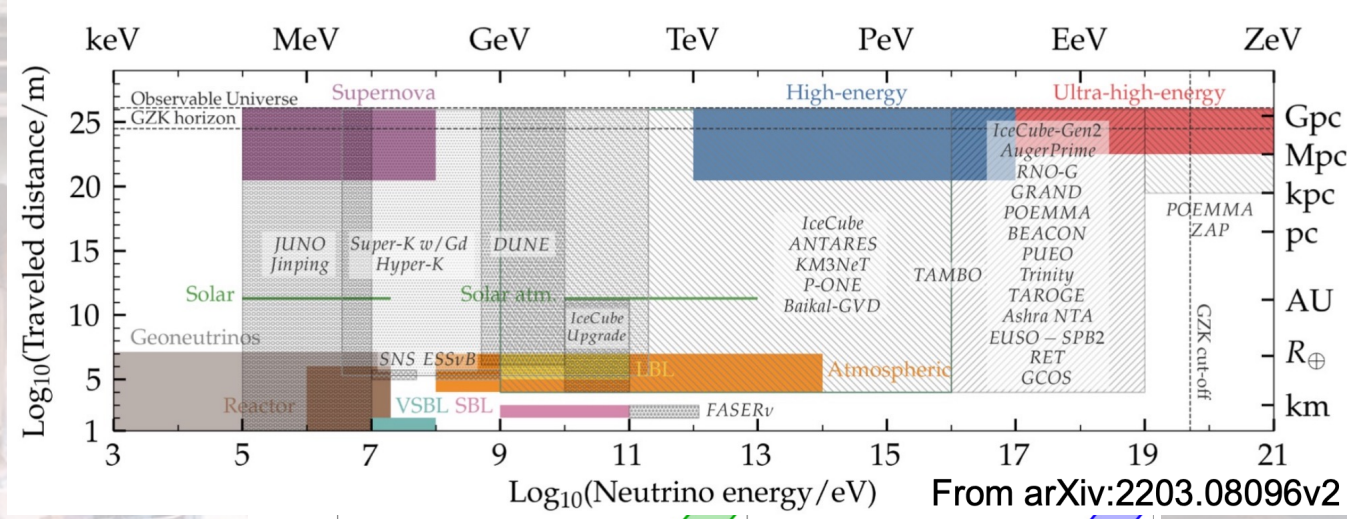


All LBNF drifts now exist for their full length and are expanding to their design cross-sections. Detector drift is full width for part of the length. (photo J. Hall)

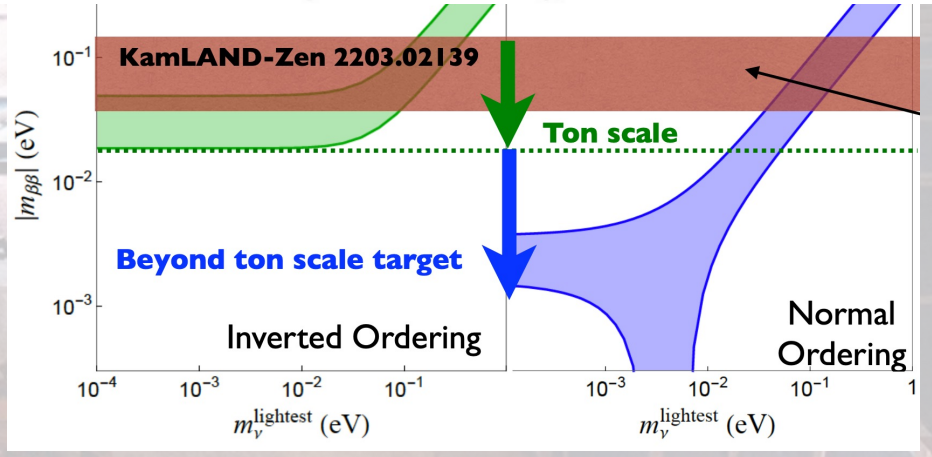
Other neutrino and rare process science goals require substantial underground infrastructure

- Experiments studying natural sources of neutrinos and reactors require underground space and infrastructure
- Large, deep space and infrastructure are required for current generation neutrinoless double-beta decay experiments
- Depth requirements for ‘beyond ton scale target’ are important to enable decisions on options in SURF expansion plans to compete for next generation concepts after the ton scale
  - Advanced planning is required due to the timescale for development of underground infrastructure

NF Summary Talk by K. Scholberg



From arXiv:2203.08096v2

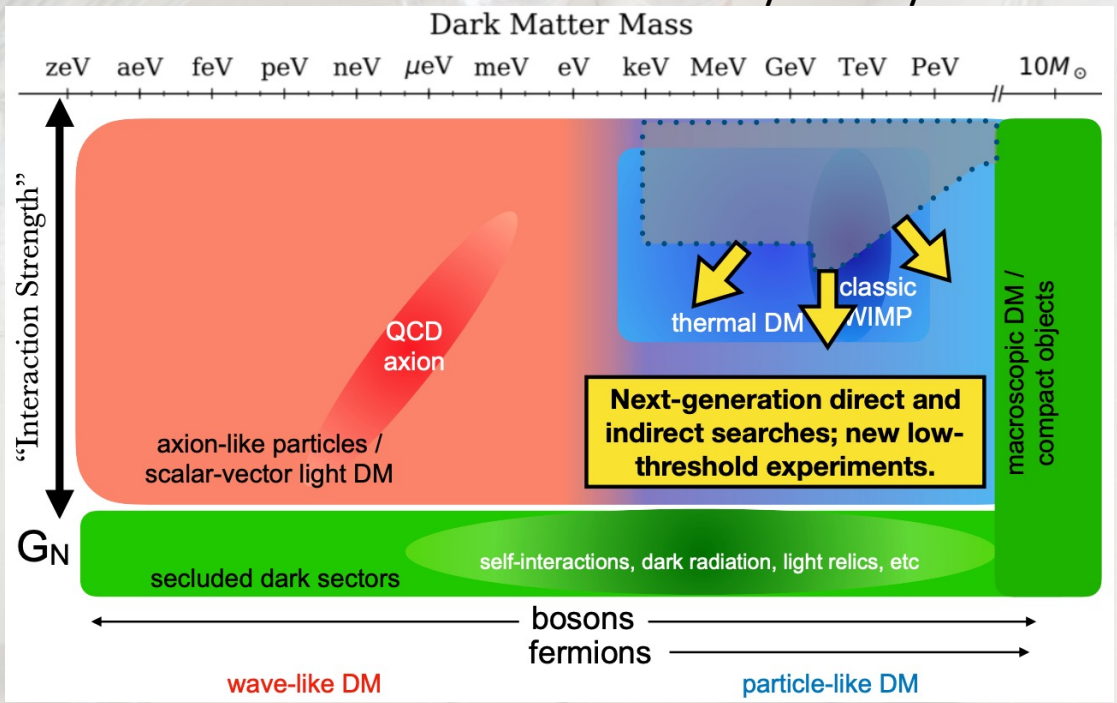


RP Summary Talk by V. Cirigliano

and Cosmic Frontier goals require substantial underground infrastructure

- "Paths to" talks from T. Slatyer, K. Dawson, and R. Wechsler demonstrated the exciting, complimentary discovery spaces accessible in the next decade of CF research
- Next generation dark matter searches at high mass will require large facilities and have exquisite background requirements
- Next generation low threshold dark matter searches will require facilities for small to medium size projects
- R&D for next generation devices and projects will involve unique underground infrastructure

CF Summary Talk by A. Chou



UFI are important for the goals to delve deep and search wide. However, we tend to aim low in UFI.

Clean, radon free space and more sensitive assay are needed for future projects

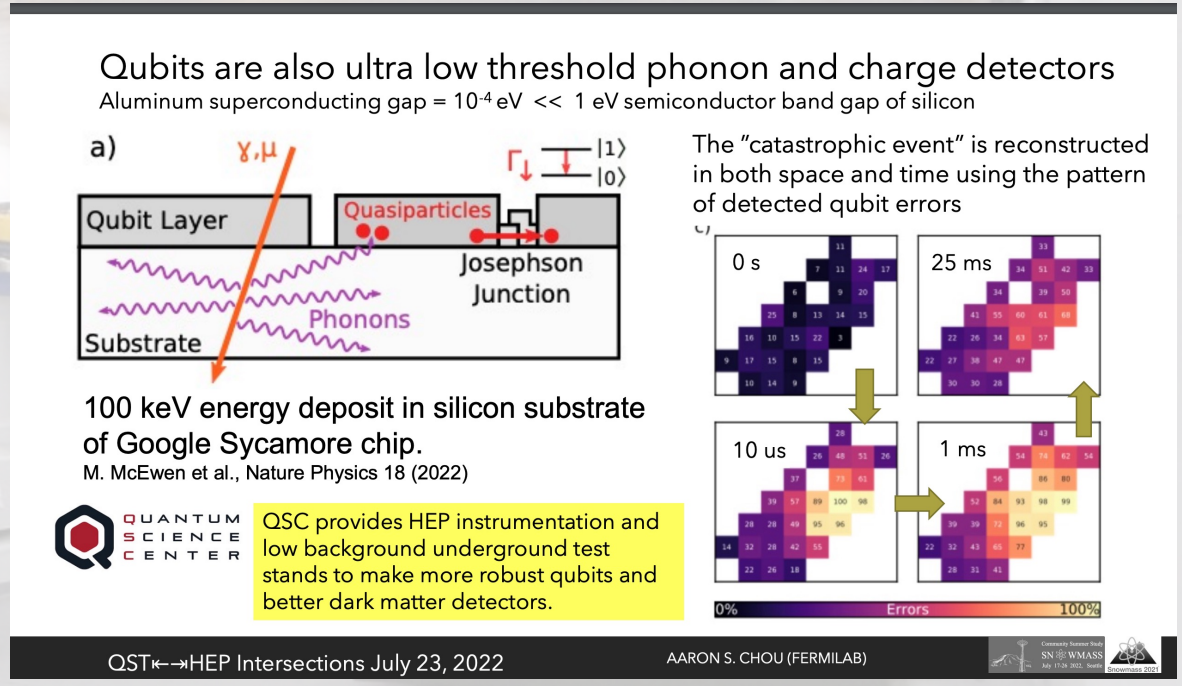
- Substantial 0vbb and dark matter goals require **larger clean rooms with lower radon levels** than currently exist
- Increase **monitoring** efforts on radon concentration and radon progeny plate out
- Most assay needs may be met by existing worldwide facilities with **organized cooperation between facilities and experiments**

UF4 Summary Talk by A. Kamaha

Research to improve assay sensitivity will reduce scientific risk in future projects

Underground facilities and infrastructure enable science, research, and development across a variety of fields

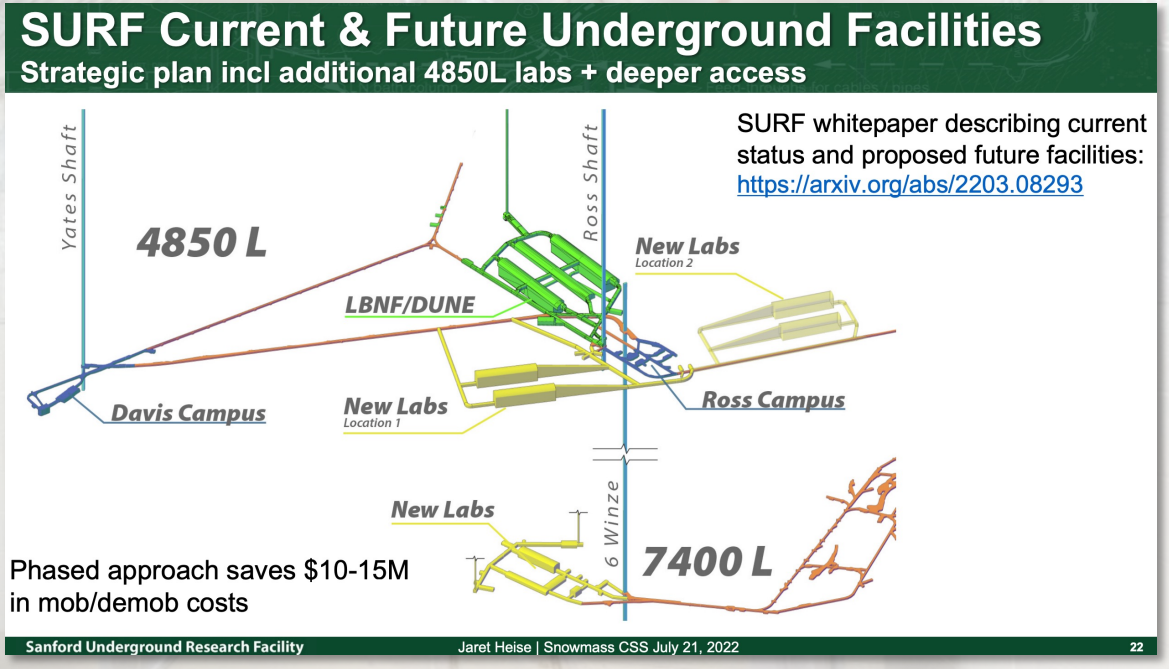
- Synergy between dark matter requirements and QST development
- Engineering including geothermal energy and underground operations
- Access to ancient water facilitates unique geology and biology studies
- Nuclear non-proliferation



Underground test facilities are part of the requirements to improve QST device sensitivity and understand radiation hardness issues for QST devices

The ambitious Snowmass community vision requires additional underground facilities and infrastructure over the next decade

- Neutrinos, rare processes, and cosmic frontier experiments and enabling R&D require more space than available
  - Expanding SURF represents an opportunity to expand US leadership in discovery science
- **Leverage the LBNF excavation enterprise to increase underground space at SURF** in a ***timely*** and cost-effective way to allow the US to compete for siting next-gen WIMP dark matter experiments
- Additional space and facilities for research and development will enable the program including particle and nuclear physics and others like QST R&D, engineering, geology, biology, etc.
  - **Make SURF an SDSTA-managed DOE User Facility** to foster cross-cutting underground science in the US
- Invest in the diversity of people and expertise required for the design, installation, integration, and operations of this increasingly complex program



SURF expansion would enable US leadership in many aspects of underground science